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# Interleaved flyback micro inverter based solar photovoltaic power generation system

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*PV generation is one of the fast growing renewable generation system to avoid the energy shortage. The micro-inverter system is best option for maximum energy harvest from each solar panel and easily we can expand the installed capacity. Now a day it is playing big role in rooftop system. These inverters divided as a single stage and double stage micro inverter. Compare to single stage double stage system having high efficiency with regulated waveforms. Interleaved flyback boost converter topology is used for improve the efficiency. Converter is high step up DC-DC boost with MPPT, MPPT is used to vary the duty cycle to generate maximum power from each panel both healthy and partial shading condition. MPPT voltage range from 27 V to 45 V, for 200 W, lower maintenance cost and higher energy yield with open-circuit voltage below 45 V. Micro-inverter PV system can achieve up to 25% lower energy cost compared to the conventional central inverter system*

***Keywords:*** *MPPT; micro-inverter; AC panel; flyback; interleaved;*

## 1.0 INTRODUCTION

Solar inverter systems main requirements extract more energy from each panel and grid synchronise, in central inverter using MPPT for energy harvest but which is for entire string. During partial shading condition due to one panel entire string output reduced. But in micro inverter attached with panel itself so which is extracting maximum available power from each panel even in partial shading condition. This entire system is called AC panel [1-2].

Compare and contrast of micro inverter [3] include:

- Central inverter fail may cause system fail.
- Partial shading reduces total output by 25% or 50% possibly 100% in central inverter.
- Micro inverter giving same output but which is having 5% to 20% energy harvest compare to central installations
- Avoid dangerous DC cabling system on roof top
- AC breakers cheaper than DC breakers.

## 2.0 INTERLEAVED FLYBACK CONVERTER

In this micro inverter DC to DC converter is an isolated interleaved boost converter. The basic structure of the inverter is shown in Figure 1.

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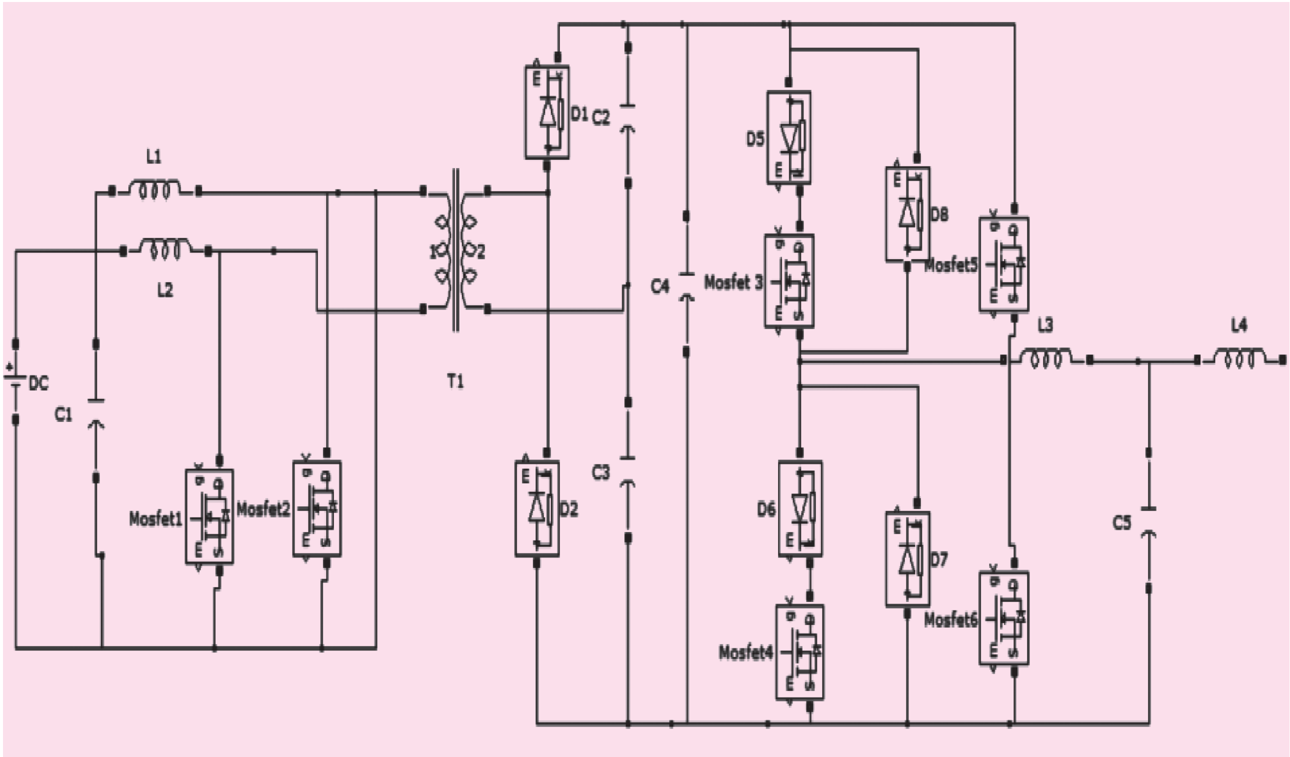


FIG. 1 FLYBACK CONVERTER

It consists of a high frequency transformer with primary side capacitor $C_1$ and inductors $L_1$, $L_2$ and $MOSFET_1$, $MOSFET_2$. In secondary side three capacitors $C_2$, $C_3$ with rectifier diodes, $C_4$. HF transformer output is further boosted by a voltage doubler circuit [4]. Compare to a standard four rectifier diodes to halve the transformer turns ratio, shorter secondary winding which gives better primary to secondary coupling flux and secondary side conduction loss very less. MOSFETs are derived with 180 degree phase shift with respect to each other and duty cycle >0.5.

D= time beyond $T_S/2$ for which the MOSFET is still closed[5]

$$D_{max} = \frac{t_{onmax}}{T_S} \quad ....(1)$$

$$V_O = \frac{(2.Vin)}{(1-D)} \times \frac{N_2}{N_1} \quad ....(2)$$

$$t_{onmax} = 0.7 \times T_S \quad ....(3)$$

Calculation of maximum input power

$$P_{in} = \frac{P_{out}}{\eta} \quad ....(4)$$

Calculation of maximum average input current

$$I_{outmax} = \frac{P_{out}}{V_{outmin}} \quad ....(5)$$

Calculation of transformer turns ratio:

$$\frac{N_2}{N_1} = \frac{\frac{V_{out}}{2} \times (1-D)}{2V_{in}} \quad ....(6)$$

$V_{in}$- average between the maximum and minimum input voltage value[6].

The minimum value of capacitance required on the DC bus is calculated according to the Following equation:

$$C_{bus} = \frac{4 \times P_{out}}{V_{bus\ \min}^{2}} \times t_1 \quad ....(7)$$

Where $t_1$=5ms

$L_f$ is designed in order to limit the current ripple to about 20% of the nominal current value. The following equations have been used to calculate the filtering inductance

Where n is the number of inverter levels (+$V_{bus}$, 0 and -$V_{bus}$) and D is the inverter duty cycle[7].

Value:\

$$L_f = \frac{1}{n} \times \frac{(V_{bus} - V_{grid_{pk}}) \times D}{\Delta i \times f_{sw}} \quad ....(8)$$

Resonant frequency

$$f_{res} = \frac{1}{2 \times \pi} \times \sqrt{\frac{L_f + L_g}{L_f + L_g + C_f}} \quad ....(9)$$

## 3.0 OPERATION OF AN INTERLEAVED FLY-BACK CONVERTER

Source pins of MOSFETs source pins connected to ground and the high frequency transformer connected to drain. When input indictor current interrupted Voltage limited by the zener diode connected between drain and source. Two switching transitions controlled by gate resistance. At stage 1 the fly back $MOSFET_1$ and $MOSFET_2$ turns ON and energy stored in inducted at that time secondary side diode $D_1$ and $D_2$ in reverse bias due to secondary winding voltage and out is supplied by a capacitor $C_4$, Primary of transformer behaves like an inductor and primary current rises linearly.

When $MOSFET_1$ and $MOSFET_2$ turn off stored energy in primary side is transferred to secondary winding so diode $D_1$ and diode $D_2$ gets forward bias. During this time current to load directly supplied through secondary winding and capacitor $C_4$ charged. Driver circuit input send by opto-coupler and whose input for opto-coupler send by micro controller through high frequency leg and low frequency leg [8]. Short-Circuit hardware protection is given by two zero Ohm shunt resistors.

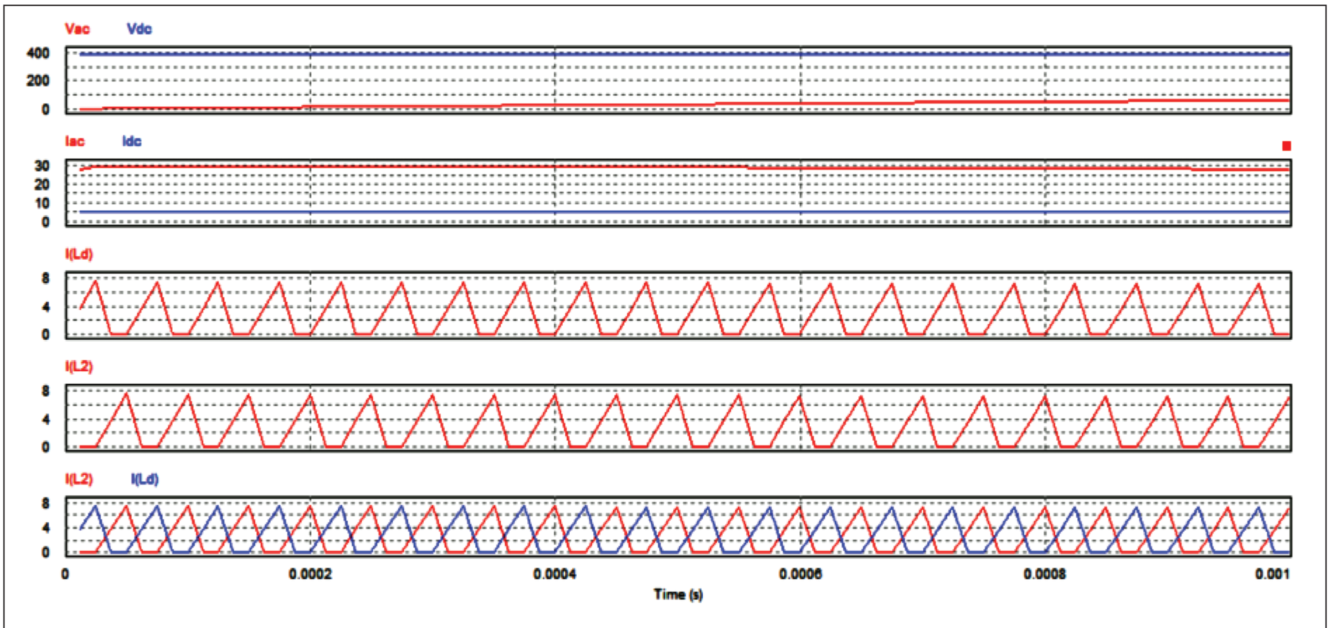


FIG. 2 OUTPUT WAVEFORMS

## 4.0 CONCLUSION

In this paper a interleaved flyback boost converter with super-fast H bridge was proposed in which, depending on various input level flyback converter boost the voltage.

The main conclusions are

- Maximum available power from single panel extracted.
- Switching losses reduced by using interleaved soft switching.
- The analytical equations derived for describing the smooth operating mode.
- Simulation result and hardware setup shown, efficiency increases in lower power levels also compared to conventional inverters.

## REFERENCES

[1] Gagrica, Ognjen, W L Kling, and T Uhl. Control of micro-inverters as an overvoltage prevention method under high PV-penetration. Mechanics and Control 32, 2013.

[2] Cg-L Chenga, Lg-Mei Liaoa, Chia-PengChoub, A study of summarized correlation with shading performance for horizontal shading devices in Taiwan, Solar Energy, Vol. 90, pp. 1–16, April 2013.

[3] W T Da Costaa, J F Fardinb, L de Vilhena B. Machado Netoc, Estimation of irradiance and temperature using photovoltaic modules", Solar Energy Vol. 110, pp.132–138, December 2014.

[4] B Goss, I Cole, T Betts, R Gottschalg, Irradiance modelling for individual cells of shaded solar photovoltaic arrays, Solar Energy Vol. 110, pp. 410–419, December 2014.

[5] D Lauria, M Coppola, Design and control of an advanced PV inverter, Solar Energy Vol. 110, pp. 533–542, December 2014.

[6] R C Variath, M A E Andersen, O N Nielsen and A Hyldgard, A review of module inverter topologies suitable for photovoltaic systems, in Proc. IEEE IPEC, pp. 310-316, 2010.

[7] H GABLER, Grid-Connected PV/Grid-Connected Photovoltaics, Solar Energy Vol. 70, No. 6, pp. 455–456, 2001

[8] S Vijayalekshmya, G R Bindua, S Rama Iyer, A novel Zig-Zag scheme for power enhancement of partially shaded solar arrays, 2016.

[9] W-J Chaa, J-M Kwonb, B-H Kwona, Highly efficient step-up DC–DC converter for photovoltaic micro-inverter, 2016.

[10] S J Buckleb, Ns-D, b, Ajay Gambhirb, J Nelsona, Off-grid solar photovoltaic systems for rural electrification and emissions mitigation in India, May 2016.

[11] A Ghosh, B Norton, A Duffy, First outdoor characterisation of a PV powered suspended particle device switchable glazing, Solar Energy Materials and Solar Cells Vol. 157, pp. 1–9, December 2016.

[12] P Elanchezhian, V K Chinnaiyan, R Sudhir Kumar, Review of three port micro-inverter with power decoupling capability for photovoltaic (PV) systems applications, The CPRI Journal, Vol. 11, No. 3, pp. 561-570, 2015.

[13] P Elanchezhian, V K Chinnaiyan, R Sudhir Kumar, Design Of LCL Filter For Micro Inverter, CPRI Journal, Vol. 11, No. 4, pp. 735-740, December 2015.

[14] P Elanchezhian, V Kumar Chinnaiyan, R Sudhir Kumar, Design of two-stage soft-switched module Inverter for Photovoltaic applications, The Journal of CPRI Vol. 11, pp.145-154, March 2015.

[15] P Elanchezhian, Soft-Switching Boost Converter for Photovoltaic Power-Generation System with PSO Based MPPT, International Journal of Communications and Engineering, Vol. 06, No. 01, pp. 121-128, March 2012.